Instruction Manual

MODEL A88

ISOLATION AMPLIFIER

FLUKE

ELECTRONICS FOR INDUSTRY
INSTRUMENTS / COMPONENTS

JOHN FLUKE MFG. CO., INC.
P.O. Box 7428 Seattle, Washington 98133

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MODEL A88

ISOLATION AMPLIFIER

A88 Serial No. 123 and above.

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MODEL A88 ISOLATION AMPLIFIER

Tom Robinson
MS-47-87

SECTION I

INTRODUCTION AND SPECIFICATIONS

1-1. INTRODUCTION

1-2. GENERAL

1-3. The Fluke Model A88 Isolation Amplifier is a solid-state dc amplifier. The two primary characteristics of the instrument are, first, high isolation of the input from ground, and second, high isolation of the input from the output. Uses of the A88 include: use as a floating null amplifier, use as a transducer amplifier, use as a thermocouple amplifier, and use as a bridge output amplifier.

1-4. The A88 is well suited for use as an accessory with Fluke Differential Voltmeters for recording voltmeter deflection. The high input isolation of the A88 relieves the necessity of using recorders having high leakage resistance and high input resistance. Use of the A88 permits monitoring the recorder output of differential voltmeters with nearly all potentiometric type recorders and with many electromechanical pen recorders.

1-5. The input signal to the A88 is coupled to the instrument circuitry through a unique magnetic field. This makes possible the high input isolation of the instrument.

1-6. RECEIVING INSPECTION

1-7. This instrument has been throughly inspected and tested before being shipped from the factory. Immediately after receiving the instrument, carefully inspect for damage which may have occurred in transit. If any damage is noted, follow the instructions outlined in the Warranty section in the back of this manual.

1-8. SPECIFICATIONS

1-9. ELECTRICAL

GAIN: 1 volt output per microampere input.

GAIN ACCURACY: ±2%.

INPUT CURRENT RANGE: 0 to ±2 microamperes.

INPUT VOLTAGE RANGE: 0 to ±2 millivolts nominal.

INPUT RESISTANCE: 950 (±5%) ohms.

OUTPUT VOLTAGE RANGE: 0 to ±2 volts, open circuit.

OUTPUT RESISTANCE: 1000 (±5%) ohms.

MAXIMUM OUTPUT CURRENT: 1 milliampere.

LINEARITY: Better than 0.4% of full output.

TEMPERATURE COEFFICIENT OF GAIN: Less than 0.05%/° C.

INPUT ISOLATION FROM CHASSIS: Greater than 5×10^{11} ohms at 25° C (77° F) and 60% relative humidity: greater than 10^{10} ohms at 50° C (122° F) and 80% relative humidity (1100 volts maximum dc potential between input and chassis.)

NOISE: Less than 1.5 nanoamperes rms (5 nanoamperes peak-to-peak), at the input.

DRIFT WITH TIME: Less than 12 nanoamperes per week referred to the input.

POWER SUPPLY REQUIREMENTS: 11.7 to 14 volts nominal, 10 milliamperes, with less than 10 millivolts rms ripple and less than 150 ohms source resistance.

DRIFT WITH TEMPERATURE: Less than 0.4 nanoamperes per degree Centigrade.

RESPONSE: Small signal bandwidth - 0 to 2.7 cps (3db down). Speed of response - Less than 0.2 seconds, 0 to 90% of full range output.

AC NORMAL MODE REJECTION: Up to 700 nanoamperes rms produces no discernible output signal from 50 cps to 500 cps.

DC COMMON MODE REJECTION: Up to 1100 volts produces no discernible output signal.

AC COMMON MODE REJECTION: Up to 3 volts rms produces no discernible output signal from 50 cps to 500 cps.

OVERLOAD: At least 6 milliamperes without damage.

1-10. MECHANICAL

TEMPERATURE RANGE: Operating: 0° C to 50° C (32° F to 122° F)
Storage: -40° C to 85° C (-40° F to 185° F)

RELATIVE HUMIDITY: 0 to 80%.

VIBRATION: MIL-T-945A.

SHOCK: MIL-E-4970A (20g's, 11 milliseconds).

POWER SUPPLY OPTIONS: A84-2 Mercury Battery Kit - Two Mallory TR-135R mercury batteries for approximately 100 hours of operation.

A84-3 AC Power Pack for operation from 115/230 (±10%) vac, 50 to 440 cps, 1 watt.

A84-4 Rechargeable Battery Pack - Ten nickel-Cadmium cells with recharging power supply for more than 100 hours of operation per full charge. A metal case is included which mounts the A88 and the battery pack side-by-side.

MOUNTING:

OEM Panel Mount - Unterminated wire leads for input, output, and external on-off switching in addition to the front panel on-off switch.

Metal Instrument Case - Input and output leads terminated at rear binding posts.

SIZE: Approximately 5-1/2" high by 3" wide by 4-3/4" behind the front panel without the case. (Case depth is 6-1/2" behind the panel including the rear terminals.) Size is approximately 5-1/2" high by 6" wide by 6-1/2" behind the front panel including the rear terminals with the rechargeable battery pack and case.

WEIGHT: 1-1/2 pounds without batteries and case: 3 pounds with batteries and case.

SECTION II

OPERATING INSTRUCTIONS

2-1. FUNCTION OF EXTERNAL CONTROLS AND TERMINALS

2-2. The function of external controls and terminals on the A88 are given in Figure 2-1.

2-3. MOUNTING IN ANOTHER INSTRUMENT

2-4. The A88 may be mounted in another instrument as follows:

a. Prepare the panel of the instrument according to Figure 2-2.
b. Mount the A88 to the panel of the instrument with four 6-32 x 1/2" screws and four #6 flat washers.
c. The red/white and yellow/white wires provide a means of connecting power to the A88 through the on-off switch of the other instrument, so that the operator does not have to remember to set the A88 POWER switch to off to conserve battery life. Solder these wires to the power switch of the other instrument, if desired. Otherwise, twist these wires together, solder, and insulate.
d. Connect red wire to positive input, and connect black wire to negative input. Connect black/white wire (chassis ground) and orange wire (± OUTPUT) to device for which output is intended.

2-5. MOUNTING IN A84-1 CASE

2-6. If an A88 and an A88-1 case are ordered separately, they can be assembled as follows:

a. Remove the two screws at the back of the case and separate the sides.
b. Twist red/white and yellow/white wires together, solder, and insulate.
c. Solder red wire to ± INPUT binding post, and solder black wire to the other INPUT binding post. Solder orange wire to ± OUTPUT binding post, and solder black/white wire to black OUTPUT binding post.

CONTROL OR TERMINAL	LOCATION	REFERENCE DESIGNATION	FUNCTION
POWER switch	Front panel	S1	Applies operating voltage to the instrument circuitry.
BATT TEST terminals	Front panel	J5 & J6	Provided for measuring battery potential. The red terminal (J5) should measure 11.7 to 14 vdc, with respect to the black terminal.
INPUT terminals	Back panel	J1 & J2	Provided for connecting the source to be measured to the A88. The input resistance of the A88 is 950 ohms.
OUTPUT terminals	Back panel	J3 & J4	Provided for connecting the indicating instrument to the A88. The output resistance of the A88 is 1000 ohms.
ZERO adjustment	Back panel	R31	Provided for setting the instrument output to zero with zero input.

Figure 2-1. FUNCTION OF EXTERNAL CONTROLS AND TERMINALS

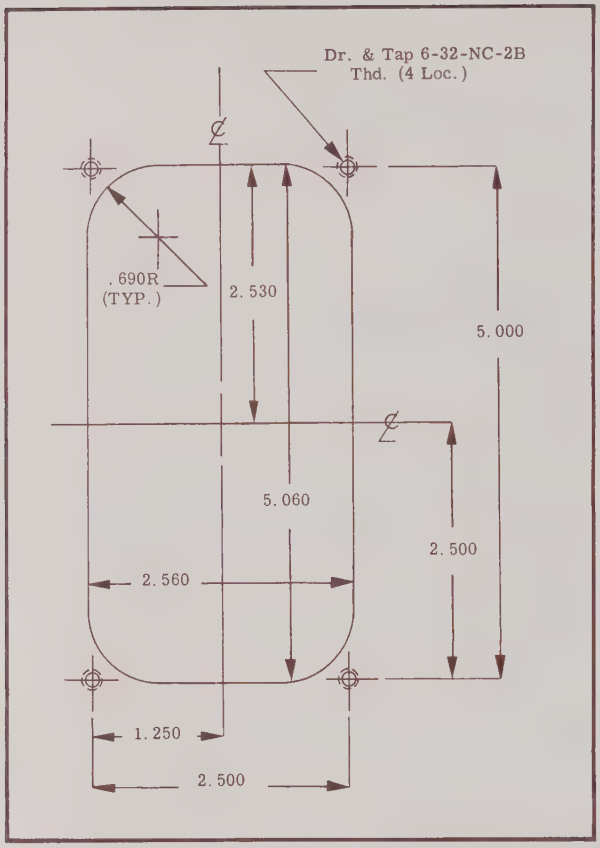


Figure 2-2. INSTRUMENT MOUNTING HOLES DIMENSIONS

d. Stamp A88 serial number on decal on back of case, if desired.
e. Fold extra lead length over chassis top while placing the A88 in case.
f. Replace sides and fasten with 2 screws.
g. Mount A88 in case with four screws and washers provided.

2-7. BATTERY KIT INSTALLATION

2-8. The A84-2 Mercury Battery Kit consists of two Mallory TR-135R mercury batteries (6.75 volts each) which can be installed as follows:

a. Remove four front panel screws of A88 and slide A88 out of case.
b. Install batteries so that polarity marked on batteries matches polarity marked on battery clips. The case of the mercury battery is positive.

CAUTION

To prevent possible damage due to electrolyte leakage, remove the batteries before: (a) shipping the instrument, (b) storing the instrument for a period exceeding 30 days, or, (c) storing the instrument for any period of time at a temperature exceeding 50° C.

c. Place A88 into case or instrument and replace front panel screws.

2-9. INSTALLING AC POWER PACK

2-10. The Model A84-3 AC Power Pack can be installed as follows:

a. Remove four front panel screws from A88 and slide A88 out of case.
b. If batteries are installed, remove from clips. Do not dispose of mercury batteries by means of fire.
c. If A88-1 case is used, pass line cord through hole provided.
d. Connect red marked lead to terminal designated positive closest to front panel, and connect black marked lead to adjacent terminal with screws and nuts provided.
e. Place A88 into case assembly or instrument, and replace four front-panel screws.

2-11. USE WITH A DIFFERENTIAL VOLTMETER

2-12. The A88 permits the use of a variety of strip chart recorders with the Fluke Differential Voltmeters without regard to the input isolation of the recorder. Proceed as follows:

a. Set POWER switch to ON.
b. When batteries are being used as a power source, measure voltage at BATT TEST jacks. If the voltage is between 11.7 and 14 vdc, batteries are satisfactory for use. However, if battery voltage is below 12.5 volts, the batteries are approaching the end of their useful life and should be replaced.
c. Connect recorder output terminals of differential voltmeter to INPUT terminals of isolation amplifier.
d. Connect OUTPUT terminals of isolation amplifier to input terminals of strip chart recorder.
e. Apply sufficient voltage at input of differential voltmeter to cause full-scale deflection of panel meter.
f. Set recorder gain so that a recorder input of approximately ±2 volts (or maximum input) will cause desired full-scale recorder deflection. This will correspond to full-scale deflection of the differential voltmeter.
g. Adjust output level control on differential voltmeter for full-scale deflection of recorder.
h. Remove input voltage to differential voltmeter. The voltmeter and recorder are now ready for use.
i. To prolong battery life, set POWER switch to off when A88 is not in use.

2-13. CURRENT MEASUREMENTS

2-14. The A88 can be used to measure current from 0 to 2 microamperes, as follows:

a. Connect current to be measured to INPUT terminals. Use shielded leads in an area of high fields, or when the connecting leads are long.
b. Set POWER switch to ON.
c. When batteries are being used as a power source, measure voltage at BATT TEST jacks. If the voltage is between 11.7 and 14 vdc, batteries are satisfactory for use. However, if battery voltage is below 12.5 volts,

the batteries are approaching the end of their useful life and should be replaced.

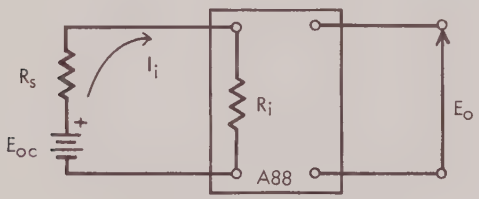
d. Connect a voltmeter to OUTPUT terminals, and measure output voltage. Since there is 1 volt output per microampere of input current, the input current can be easily computed.

e. To prolong battery life, set POWER switch to off when A88 is not in use.

2-15. VOLTAGE AMPLIFICATION

2-16. The A88 may be used as a voltage amplifier with a gain of approximately 1000. Full range input of ±2 millivolts produces an output of ±2 volts. The 950 ohm input resistance of the A88 should be considered when monitoring sources with a source resistance greater than approximately 100 ohms. This is determined as follows:

a. The diagram below represents an A88 being used for voltage amplification.



where: E_{oc} = Open circuit voltage of source

E_o = Output voltage of A88

R_s = Source resistance

R_i = Input resistance of A88 (950 ohms).

I_i = Input current to A88

b. The equation for E_{oc} in terms of E_o, R_s, and R_i, is:

$$E_{oc} = \frac{E_o (R_s + R_i)}{1000\ R_i}$$

If R_s is less than 100 ohms, the equation simplifies to:

$$E_{oc} = \frac{E_o}{1000}$$

c. To use the A88 as a voltage amplifier, perform the steps of paragraph 2-14, as if making a current measurement.

2-17. USE AS A NULL DETECTOR

2-18. The A88 may be used as a low-level amplifier in null detector circuits, such as bridge circuits or potentiometers. Proceed as follows:

a. Connect INPUT terminals of the A88 to circuit being measured.

b. Set POWER switch to ON.

c. When batteries are being used as a power source, measure voltage at BATT TEST jacks. If voltage is between 11.7 and 14 vdc, batteries are satisfactory. However, if battery voltage is below 12.5 vdc, the batteries are approaching the end of their useful life and should be replaced.

d. Connect a voltmeter to OUTPUT terminals and adjust circuit under measurement for a null on the voltmeter.

e. To prolong battery life, set POWER switch to off when A88 is not in use.

2-19. OVERLOAD

2-20. The instrument will withstand a maximum overload of 6 milliamperes, and should return to normal operation within a few seconds after the overload is removed. If difficulty in zeroing the instrument results, setting the POWER switch to ON and then to off a few times will correct the condition.

SECTION III

THEORY OF OPERATION

3-1. INTRODUCTION

3-2. A block diagram of the A88 Isolation Amplifier is given in Figure 3-1. The instrument consists of a 2.5KHz oscillator, a magnetic modulator, a 5KHz amplifier, a synchronous demodulator, and a dc amplifier.

3-3. Operation of the instrument may be summarized as follows: Application of a dc input to the magnetic modulator produces a 5KHz signal, the amplitude of which is proportional to the input current. This signal is then amplified and applied to the synchronous demodulator, which is also supplied with a 5KHz signal from the oscillator and frequency doubler. The demodulated voltage is then amplified, fed back to the demodulator, and applied to the output. A more detailed description of each part of the circuit is given in the following paragraphs.

3-4. CIRCUIT DESCRIPTIONS

3-5. PUSH-PULL OSCILLATOR AND FREQUENCY DOUBLER

3-6. The oscillator is a push-pull, tuned-collector oscillator, in which each transistor shares approximately one-half of the signal. Capacitor C1 and the primary winding inductance of T1 determine the frequency of oscillation. Tuning to 2.5KHz is accomplished by means of the variable core of T1. The regenerative signal is applied to the base of Q1 and Q2 through voltages induced in the secondary of T1. The 2.5KHz signal is coupled magnetically into the two lower windings on T1, and applied to magnetic modulator T2. The amplitude of the oscillator is controlled by monitoring the current in the output windings through R9. The voltage at the base of Q4 varies the base current

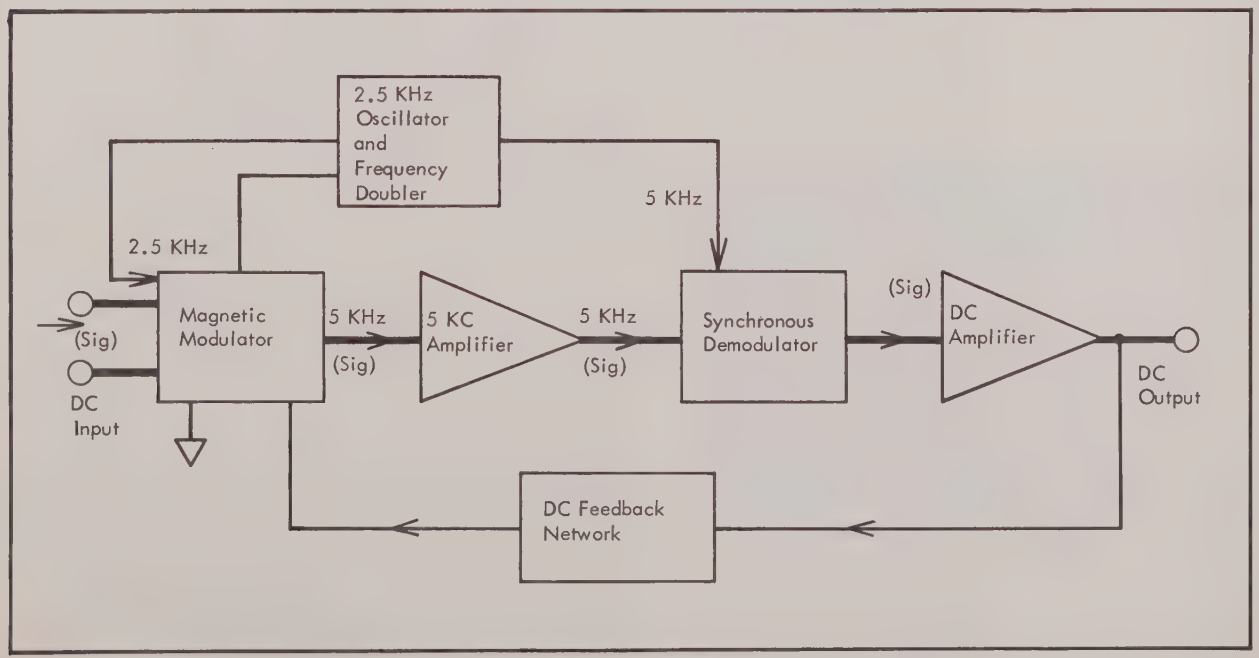


Figure 3-1. A88 ISOLATION AMPLIFIER - BLOCK DIAGRAM

of Q1 and Q2, which varies the output amplitude of the oscillator. Although each transistor conducts approximately one-half of the time, the emitter current of both Q1 and Q2 flows through R2 in the same direction. Consequently, the voltage across R2 is a full-wave rectified, 2.5KHz sine wave. The voltage across R2 is the input to Q3, which provides current gain for the 5KHz signal, and shapes the pulse to an approximate square-wave, which is applied to the synchronous demodulator, Q8.

3-7. MAGNETIC MODULATOR

3-8. The magnetic modulator, T2, includes an ac input drive winding, a combined dc input/ac output winding, and a dc feedback winding. The oscillator supplies an alternating current of 2.5KHz to the ac input winding on T2. Applying a dc input current shifts the operating point of the modulator, which results in a second harmonic output signal, or 5KHz. The transfer function of the magnetic modulator, I_{ac}/I_{dc}, is linear over the input range of the instrument. Reversing the polarity of the dc input voltage will shift the 5KHz waveform 180°. This makes possible recovery of the input voltage polarity by using a phase-sensitive demodulator.

3-9. TUNED 5KHz AMPLIFIER

3-10. The second harmonic produced in T2 flows through C12 and the primary of T3, and is thus applied to the input of the 5KHz tuned amplifier, which consists of three stages of common emitter ac amplification, Q5, Q6, and Q7. The secondary of T3 and C13 form a 5KHz parallel resonant circuit, which separates the 5KHz signal. A series resonant circuit composed of L1 and C15 in the emitter of Q5 provides frequency-dependant negative feedback from the emitter of Q7. Frequencies other than 5KHz encounter a higher impedance in this resonant circuit, which provides higher feedback and reduces the gain of the tuned amplifier to these frequencies.

3-11. SYNCHRONOUS DEMODULATOR

3-12. The 5KHz signal applied to the base of Q8 is synchronized with the 5KHz output from Q7, which operates as a phase-controlled switch. Consequently, the voltage appearing at the collector of Q8 is a dc voltage, the magnitude of which depends on the polarity and magnitude of the dc input. This dc voltage is amplified by Q9, and applied to the base of Q11. The voltage at the emitter of Q11 varies from approximately 0 to 4.5 volts. Diodes CR3 and CR4, and C7, C8, and R10 form a floating -2.5 volt dc supply, which is in series with the output from the emitter of Q11. This provides a range of output voltage from -2 volts (emitter of Q11 at 0.5 volts) to +2 volts (emitter of Q11 at +4.5 volts). Transistor Q10 is a current source for Q11, thus reducing battery drain by Q11. Resistor R31 is used to set the output to zero for zero input. Components C9, R14, and R15 form a dc feedback network for the instrument.

3-13. AC POWER PACK

3-14. Diodes CR1 and CR2, and C1, C2, and R3, form a full-wave voltage doubler circuit, which provides filtered dc voltage across CR3. Zener diode CR3 maintains the output voltage at approximately 13.5 volts. The primary of T1 can be connected for operation from either 115 vac or 230 vac.

SECTION IV

MAINTENANCE

4-1. INTRODUCTION

4-2. Maintenance of the A88 should consist primarily of occasional adjustment of the instrument zero and battery replacement. Preventive maintenance is discussed in paragraph 4-3. A discussion of troubleshooting is presented in paragraph 4-5. Calibration procedures and the equipment necessary are discussed in paragraph 4-10.

4-3. PREVENTIVE MAINTENANCE

4-4. The batteries must be replaced when the emf measured at the BATT TEST terminals falls below 11.7 volts. Replace the batteries with two Mallory type TR-135R mercury batteries as follows:

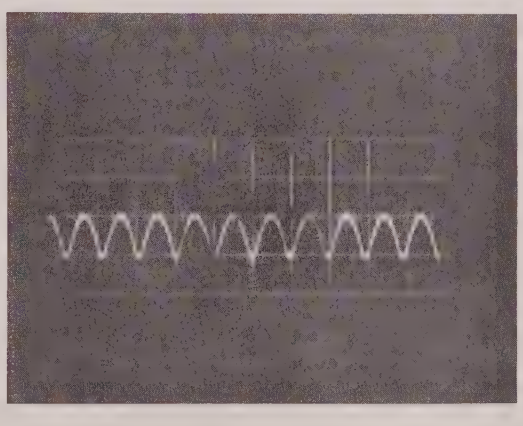
a. Remove four front panel screws of A88 and slide A88 out of case.
b. Remove old batteries. Mercury batteries may explode if disposed of in fire.
c. Install batteries so that polarity marked on batteries matches polarity marked on battery clips. The case of a mercury battery is positive.
d. Place the A88 in the case and replace the four front panel screws.

4-5. TROUBLESHOOTING

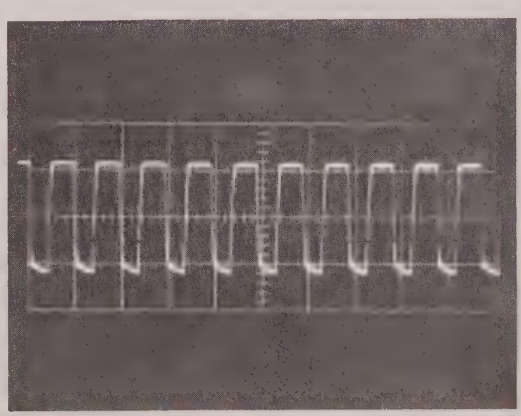
4-6. OSCILLATOR FREQUENCY

4-7. A convenient test for a defective component in the oscillator and demodulator driver is to compare the waveforms at test points G and F with those given in Figure 4-1. Test points are identified on the schematic and on the printed circuit boards. Any widely differing waveform will probably indicate a defective component. If it is suspected that the oscillator frequency is out of tolerance, proceed as follows:

a. Connect counter input (Figure 4-3) to test point H. Connect counter ground to black/white wire.
b. Using a non-magnetic screwdriver, adjust core at test point Y so that counter indicates 2,500 (±5%) Hz.



A. Waveform at Test Point G (Oscillator) (.2 m sec/cm, .05 volt/cm)



B. Waveform at Test Point F (Demodulator) (.2 m sec/cm, 2 volt/cm)

Figure 4-1. OSCILLATOR AND DEMODULATOR WAVEFORMS

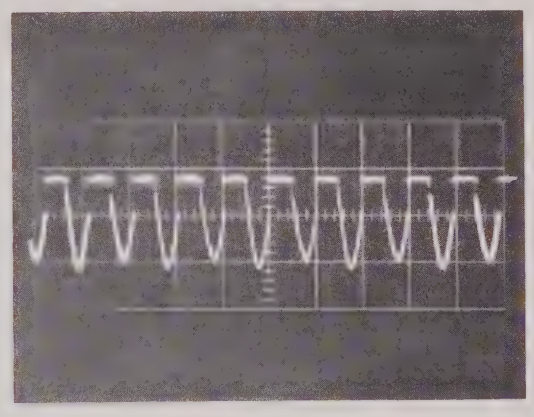
4-8. AMPLIFIER TUNING

4-9. If the oscillator frequency is reset, the tuning of the ac amplifier must be checked as follows:

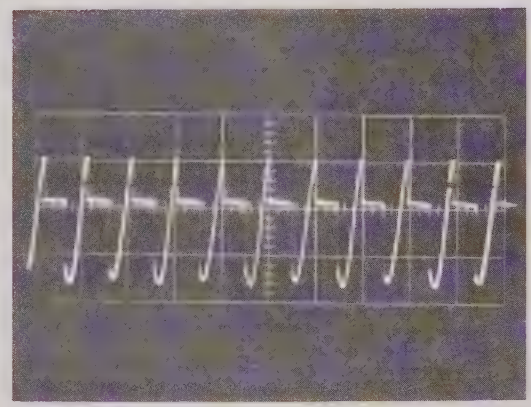
a. Short test point E to black/white wire (chassis ground).
b. Connect output of current source (Figure 4-3) to red wire of wire bundle, and connect common wire from current source to black wire in wire bundle. If an instrument is used for the current source, connect chassis of instrument to chassis ground of A88 (black/white wire). The current source must provide approximately 0.12 microamperes.
c. Connect oscilloscope vertical input to test point A. Connect oscilloscope trigger input to test point H.
d. Connect oscilloscope ground to chassis ground of A88 (black/white wire).
e. Slightly adjust cores at test points W and X with a non-magnetic screwdriver for maximum amplitude of 5KHz sine wave displayed on oscilloscope.
f. Connect oscilloscope vertical input to test point C.
g. Slightly adjust cores at test points W and X until demodulator is in phase with signal, according to waveform shown in Figure 4-2.

4-10. CALIBRATION

4-11. Calibration of the A88 consists of adjusting the ZERO control for a minimum output with zero input at any time deemed desirable. Proceed as follows:
a. Set POWER switch to ON and allow 4 minutes for instrument to stabilize.
b. Connect voltmeter positive input to OUTPUT terminal, and connect voltmeter common lead to ground terminal (black/white wire).
c. Adjust ZERO control, R31, for an output of 0 (±0.003) volts. Resistor R31 can be adjusted through the access hole in the back panel.
d. Set POWER switch to off for 30 seconds, then to ON. After 30 seconds, readjust R31, if necessary, so that voltmeter indicates 0 (±0.003) volts.



A. Correct Waveform (In Phase)
(.2 m sec/cm, 1 volt/cm)



B. Incorrect Waveform (Out-of-Phase)
(.2 m sec/cm, 1 volt/cm)

Figure 4-2. AC AMPLIFIER TUNING WAVEFORMS

RECOMMENDED EQUIPMENT	SPECIFICATIONS REQUIRED
Oscilloscope, Tektronix type 541A with Type L plug-in unit.	0.1msec/cm time sensitivity and 0.05 volt/cm voltage sensitivity.
Electronic Counter, Hewlett Packard Model 521	Must be able to measure 2.5KHz within ±0.1%.
Screwdriver	Non-magnetic
Current Source	Capable of supplying approximately 0.12 microamperes. A mercury battery and series resistor can be used, if desired.

Figure 4-3. TROUBLESHOOTING AND CALIBRATION EQUIPMENT

SECTION V

LIST OF REPLACEABLE PARTS

5-1. INTRODUCTION

5-2. This section contains information necessary to describe all normally replaceable parts. Separate assembly lists are used to describe the parts on the final assembly and various assemblies and subassemblies. Each list has a corresponding illustration on which the parts for that list are identified. Parts are called out on both lists and illustrations by reference designations from the schematic diagram. Those parts (mechanical) which have no reference designation are shown on the illustrations by Fluke stock number.

5-3. Each list provides the following information on each part:

a. The REFERENCE DESIGNATION column indicates the reference designation used on the schematic diagram.

b. The DESCRIPTION column describes the part in words, along with any applicable values, tolerances, etc. Indentation is used to show assembly, subassembly, and parts relationship. See abbreviations and symbols on next page.

c. Entries in the FLUKE STOCK NUMBER column indicate the number by which Fluke stocks the part. This number should be used when ordering parts from the Fluke factory or your Fluke representative.

d. Entries in the MFR. column indicate a typical manufacture of the part by the manufacturer's code number. Appendix A lists the manufacturers and their code numbers.

e. Entries in the MFR. PART NO. column are part numbers assigned by the manufacturer indicated in the Mfg. column.

f. The number in the TOTAL QTY column indicates the total quantity of the part used in the instrument. "REF" indicates that the total quantity of the part has been previously given. The total quantity of each part is listed the first time the part appears. All other listings of the same part refer back to the reference designation of the first appearance of the part for the total quantity.

g. The number in the REC. QTY. column indicates the recommended spares quantity necessary to support approximately one to five instruments for a period of two years. The basis used to select the recommended spares quantity is that a small group of parts will be required to correct a majority of the problems that occur. Since there is a chance that any part may fail, a stock of at least one of every part used in addition to the recommended parts will be needed for complete maintenance during one year of isolated service.

h. The USE CODE column identifies certain parts which have been added, deleted, or modified during production of the instrument. Each part for which a use code has been assigned may be identified with a particular instrument serial number by consulting the Use Code Effectivity List at the end of this section. These changes are normally made when improved components become available or when the latest circuit improvements are developed by our engineering department. The serial number listed indicates the instruments in which that particular part was used. The symbol "~" is used to indicate an approximate serial number. If a different part should be used for replacement, it is listed by Fluke stock number in the description column.

5-4. HOW TO OBTAIN PARTS

5-5. Standard components have been used whenever possible. Thus, most parts can be obtained locally. However, parts may be ordered directly from the manufacturer using the manufacturer's part number or from Fluke using the Fluke stock number. In addition, the most commonly replaced parts that can not be obtained locally may be obtained from your Fluke representative. If a part you have ordered has been replaced by a new or improved part, Fluke will normally send you this part along with an explanation.

5-6. When ordering parts from Fluke always include:

a. Reference designation, description, and Fluke stock number.

b. Instrument model and serial number.

c. Most structural parts are not listed. In this case, give complete description, function, and location of part.

5-7. ABBREVIATIONS

ac	alternating current
Al	aluminum
assy	assembly
cap	capacitor
car flm	carbon film
cer	ceramic
comp	composition
conn	connector
cps	cycles per second
db	decibel
dc	direct current
dpdt	double pole double throw
dpst	double pole single throw
elect	electrolytic
fxd	fixed
Ge	germanium
gmv	guaranteed minimum value
Hz	hertz (cycles per second)
K	kilohm
kc or Kc	kilocycle
kHz or KHz	kilohertz (kilocycles per/sec)
kv	kilovolt
kva	kilovolt-ampere
ma	milliampere
Mc or MC	megacycle
MHz	megahertz (megacycles per/sec)
meg or M	megohm
met flm	metal film
mfg	manufacturer
mv	millivolt
mw	milliwatt
na	nanoampere
pf	picofarad
piv	peak inverse voltage
plstc	plastic
pp	peak-to-peak
ppm	parts per million
rect	rectifier
res	resistor
rms	root-mean-square
sb	slow-blow
Si	silicon
S/N	serial number
sw	switch
spdt	single pole double throw
spst	single pole single throw
Ta	tantalum
tc	temperature coefficient
tstr	transistor
ua	microampere
uf	microfarad
uv	microvolt
va	volt ampere
vac	alternating current volts
var	variable
vdc	direct current volts
w	watt
wvdc	direct current working volts
ww	wirewound

5-8. PREFIX SYMBOLS

T	tera	10^{12}
G	giga	10^{9}
M	mega	10^{6}
K or k	kilo	10^{3}
h	hecto	10^{2}
da	deka	10
d	deci	10^{-1}
c	centi	10^{-2}
m	milli	10^{-3}
u	micro	10^{-6}
n	nano	10^{-9}
p	pico	10^{-12}
f	femto	10^{-15}
a	anto	10^{-18}

5-9. QUANTITY SYMBOLS

a or amp	ampere
f	farad
h	henry
hr	hour
Ω	ohm
sec	second
v or V	volt
w or W	watt

5-10. SPECIAL NOTES AND SYMBOLS

~ 000	Approximate serial number
Use 0000-000000	Part number indicated should be used if replacement is required.

REF DESIG.	DESCRIPTION	FLUKE STOCK NO.	MFR.	MFR. PART NO.	TOT. QTY.	REC. QTY.	USE CODE
	Final Assembly	A88	89536	A88-501			
	Oscillator PCB Assembly (see figure 5-2)	1702-166710	89536	A88-401	1		
	Amplifier PCB Assembly (see figure 5-3)	1702-166728	89536	A88-402	1		
J5	Banana Jack, red	2811-162065	74970	108-902	1		
J6	Banana Jack, black	2811-162073	74970	108-903	1		
S1	Switch, SPST	5106-114850	04009	20994-LH	1		
	Case Assembly (see figure 5-4)	3158-166769	89536	A88-503	OPT		
	AC Power Pack (see figure 5-5)	A84-3	89536		OPT		

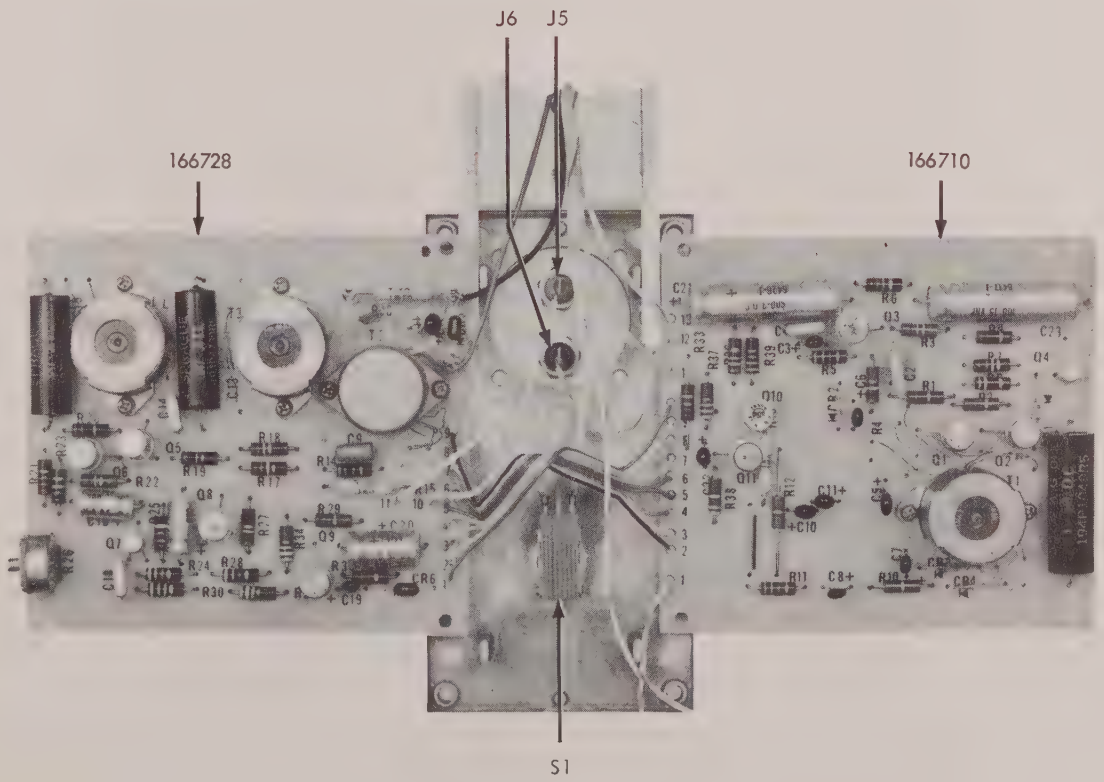


Figure 5-1. FINAL ASSEMBLY

REF DESIG.	DESCRIPTION	FLUKE STOCK NO.	MFR.	MFR. PART NO.	TOT. QTY.	REC. QTY.	USE CODE
	Oscillator PCB Assembly	1702-166710	89536	A88-401	1		
C1	Cap, plstc, 0.1 uf ±10%, 50V	1507-150318	56289	194P1049R5	1		
C2	Cap, plstc, 0.047 uf ±20%, 250V	1507-162008	73445	C280AE/P47K	4		
C3	Cap, Ta, elect, 15 uf ±20%, 6V	1508-161935	06751	TSD1-6-156	5	1	
C4	Cap, plstc, 0.047 uf ±20%, 40V	1507-162008	73445	Same as C2	REF		
C5	Cap, Ta, elect, 39 uf ±20%, 6V	1508-163915	06751	TSD2-6-396	2	1	
C6, C7, C8	Cap, Ta, elect, 15 uf ±20%, 6V	1508-161935	06751	Same as C3	REF		
C10, C11	Cap, Ta, elect, 2.2 uf ±20%, 20V	1508-161927	06751	TSD1-20-225	2	1	
C21	Cap, elect, 500 uf -10/+75%, 3V	1502-106328	56289	30D507G003DH4	1	1	
C22	Cap, Ta, elect, 1 uf ±20%, 30V	1508-161919	06751	TSD1-50-105	1	1	
C23	Cap, elect, 100 uf -75/+10%, 15V	1502-154914	56289	Type 30D	1	1	
CR1 thru CR4	Diode, Type 1N279, 35 PIV, 80 ma	4802-163907	93332	1N279	4	1	
Q1, Q2	Tstr, NPN, Si	4805-153551	07910	CDQ10449	4	1	
Q3	Tstr, PNP, Ge	4805-163188	01295	2N404	4	1	
Q4	Tstr, NPN, Si	4805-165779	95303	40231	2	1	
Q10	Tstr, PNP, Ge	4805-163188	01295	Same as Q3	REF		
Q11	Tstr, PNP, Si	4805-159491	04713	SM-4144	1	1	
R1	Res, comp, 5.6K ±10%, 1/2W	4704-108324	01121	EB5621	1		
R2	Res, comp, 120Ω ±10%, 1/2W	4704-108696	01121	EB1211	1		
R3	Res, comp, 22K ±10%, 1/2W	4704-108209	01121	EB2231	2		
R4	Res, comp, 100K ±10%, 1/2W	4704-108126	01121	EB1041	1		
R5	Res, comp, 3.3K ±10%, 1/2W	4704-108373	01121	EB3321	3		
R6	Res, comp, 12K ±10%, 1/2W	4704-108977	01121	EB1231	2		
R7	Res, comp, 220K ±10%, 1/2W	4704-108217	01121	EB2241	1		
R8	Res, comp, 39Ω ±10%, 1/2W	4704-160036	01121	EB3901	1		
R9	Res, comp, 15Ω ±10%, 1/2W	4704-165720	01121	EB1501	1		
R10	Res, comp, 120Ω ±10%, 1/2W	4704-108696	01121	EB1211	1		
R11	Res, comp, 3.3K ±10%, 1/2W	4704-108373	01121	Same as R5	REF		

REF DESIG.	DESCRIPTION	FLUKE STOCK NO.	MFR.	MFR. PART NO.	TOT. QTY.	REC. QTY.	USE CODE
R12	Res, comp, 470Ω ±10%, 1/2W	4704-108415	01121	EB4711	1		
R13	Res, met flm, 1K ±1%, 1/2W	4705-151324	75042	Type CEC-TO	1	1	
R33	Res, comp, 5.6Ω ±10%, 1/2W	4704-165738	01121	EB56G1	1		
R36	Res, comp, 24K ±5%, 1/2W	4704-108654	01121	EB2435	1		
R37	Res, comp, 33K ±5%, 1/2W	4704-108761	01121	EB3335	1		
R38	Res, comp, 3.3K ±10%, 1/2W	4704-108373	01121	Same as R5	REF		
R39	Res, comp, 3.3K ±5%, 1/2W	4704-165761	01121	EB3325	1		
T1	Transformer, A.F.	5602-166793	89536	A88-601	1		

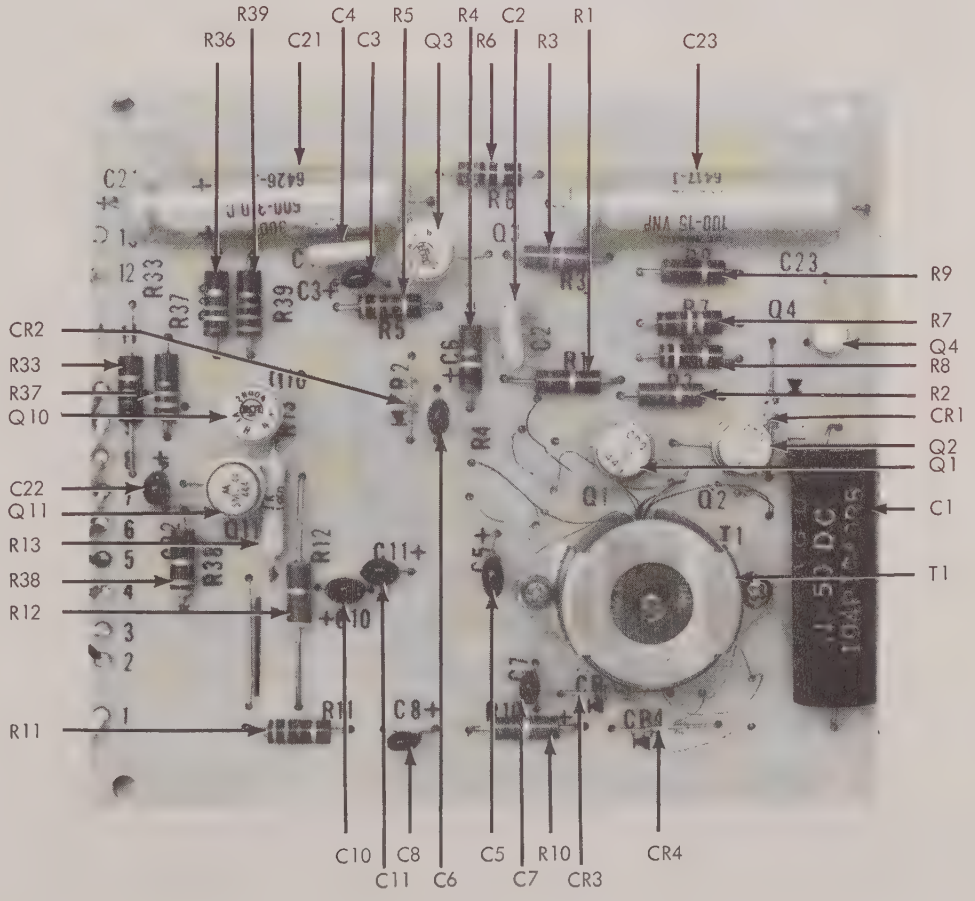


Figure 5-2. OSCILLATOR CIRCUIT BOARD ASSEMBLY

REF DESIG.	DESCRIPTION	FLUKE STOCK NO.	MFR.	MFR. PART NO.	TOT. QTY.	REC. QTY.	USE CODE
	Amplifier PCB Assembly	1702-166728	89536	A88-402	1		
C9	Cap, plstc, 0.1 uf ±20%, 40V	1507-161992	73445	C280AE/P100K	1		
C12	Cap, Ta, elect, 39 uf ±20%, 6V	1508-163915	06751	Same as C5	REF		
C13	Cap, plstc, 0.047 uf ±10%, 50V	1507-150300	56289	194P4739R5	2		
C14	Cap, plstc, 0.047 uf ±20%, 40V	1507-162008	73445	Same as C2	REF		
C15	Cap, plstc, 0.047 uf ±10%, 50V	1507-150300	56289	Same as C13	REF		
C16, C17	Cap, elect, 15 uf -10/+75%, 6V	1502-105700	56289	30D156G006BA4	2	1	
C18	Cap, plstc, 0.047 uf ±20%, 40V	1507-162008	73445	Same as C2	REF		
C19	Cap, Ta, elect, 15 uf ±20%, 6V	1508-161935	06751	Same as C3	REF		
C20	Cap, elect, 50 uf -10/+75%, 15V	1502-163741	56289	30D506G015DB4	1	1	
CR5, CR6	Diode, Si, 100 PIV, 1A	4802-116111	14099	SCE1	2	1	
L1	Inductor, var, A.F.	5602-166819	89536	A88-603	1		
Q5	Tstr, NPN, Si	4805-153551	07910	Same as Q1	REF		
Q6	Tstr, PNP, Ge	4805-163188	01295	Same as Q3	REF		
Q7	Tstr, NPN, Si	4805-165779	95303	Same as Q4	REF		
Q8	Tstr, PNP, Ge	4805-163188	01295	Same as Q3	REF		
Q9	Tstr, NPN, Si	4805-153551	07910	Same as Q1	REF		
R14	Res, comp, 8.2K ±10%, 1/2W	4704-109017	01121	EB8221	1		
R15	Res, met flm, 332K ±1%, 1/2W	4705-162503	75042	Type CEC-TO	1	1	
R16	Res, met flm, 715Ω ±1%, 1/2W	4705-150714	75042	Type CEC-TO	1	1	
R17	Res, comp, 120K ±10%, 1/2W	4704-108779	01121	EB1241	1		
R18	Res, comp, 68K ±10%, 1/2W	4704-108332	01121	EB6831	1		
R19	Res, comp, 20K ±5%, 1/2W	4704-109041	01121	EB2035	1		
R20	Res, comp, 22K ±10%, 1/2W	4704-108670	01121	EB2201	1		
R21	Res, comp, 6.2K ±5%, 1/2W	4704-108621	01121	EB6225	1		
R22	Res, comp, 22K ±10%, 1/2W	4704-108209	01121	Same as R3	REF		
R23	Res, comp, 12K ±10%, 1/2W	4704-108977	01121	Same as R6	REF		
R24	Res, comp, 4.7K ±10%, 1/2W	4704-108381	01121	EB4721	2		
R25	Res, comp, 1.8K ±10%, 1/2W	4704-108860	01121	EB1821	1		

REF DESIG.	DESCRIPTION	FLUKE STOCK NO.	MFR.	MFR. PART NO.	TOT. QTY.	REC. QTY.	USE CODE
R26	Res, comp, 1.6K ±5%, 1/2W	4704-163899	01121	EB1625	1		
R27	Res, comp, 18K ±10%, 1/2W	4704-108183	01121	EB1831	1		
R28	Res, comp, 4.7K ±10%, 1/2W	4704-108381	01121	Same as R24	REF		
R29	Res, comp, 680Ω ±10%, 1/2W	4704-108712	01121	EB6811	1		
R30	Res, comp, 47K ±10%, 1/2W	4704-108480	01121	EB4731	1		
R31	Res, var, comp, 50K ±20%, 1/4W	4701-163865	71450	UPE200-50K	1		
R32	Res, comp, 39K ±10%, 1/2W	4704-108555	01121	EB3931	2		
R34	Res, comp, 39K ±10%, 1/2W	4704-108555	01121	Same as R32	REF		
R35	Res, comp, 510Ω ±5%, 1/2W	4704-108951	01121	EB5115	1		
T2	Magnetic modulator	5602-166835	89536	A88-605	1		
T3	Transformer, A.F.	5602-166801	89536	A88-602	1		

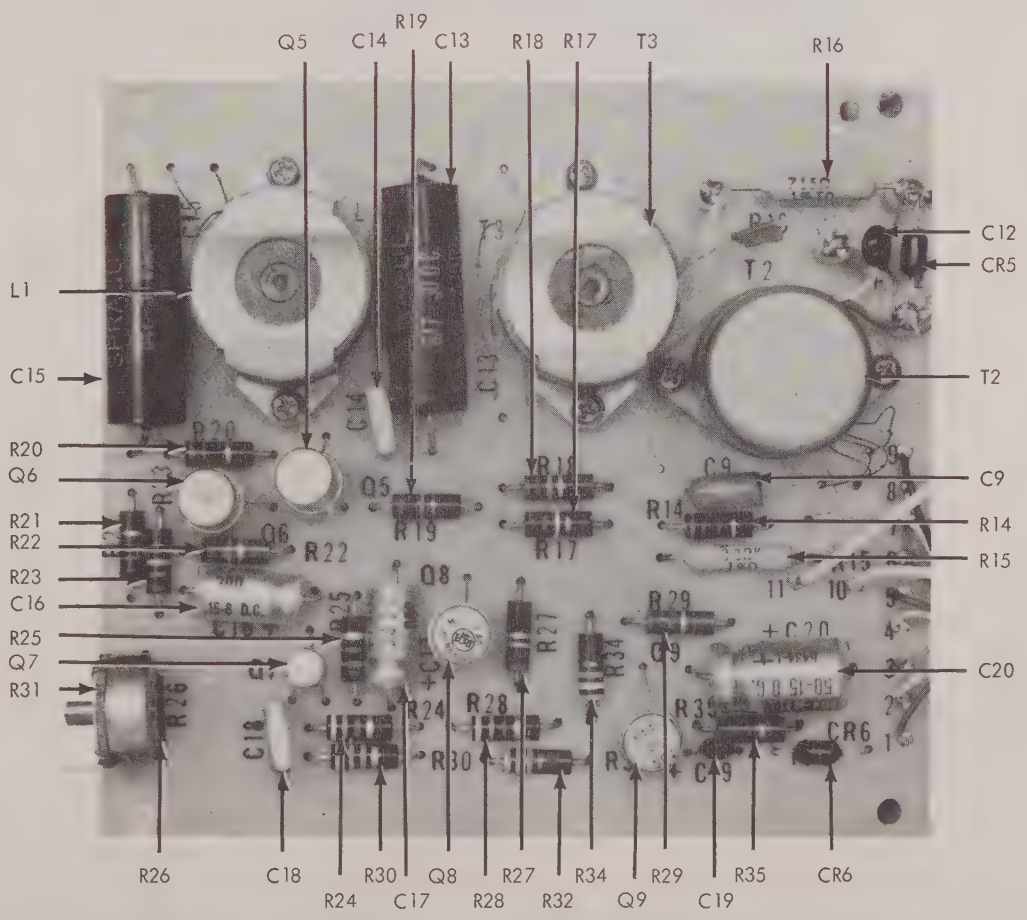


Figure 5-3. AMPLIFIER CIRCUIT BOARD ASSEMBLY

REF DESIG.	DESCRIPTION	FLUKE STOCK NO.	MFR.	MFR. PART NO.	TOT. QTY.	REC. QTY.	USE CODE
	Case Assembly	3158-166769	89536	A88-503			
J1, J2, J3	Binding post, red	2811-142976	58474	DF31RC	3		
J4	Binding post, black	2811-142984	58474	DF31BC	1		

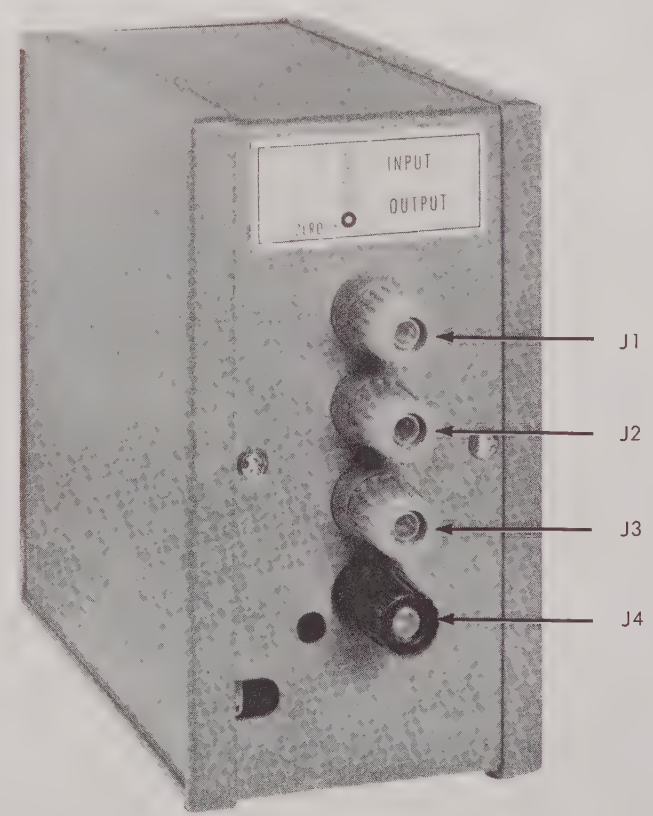


Figure 5-4. CASE ASSEMBLY

REF DESIG.	DESCRIPTION	FLUKE STOCK NO.	MFR.	MFR. PART NO.	TOT. QTY.	REC. QTY.	USE CODE
	Power Pack	A84-3	89536				
C1, C2	Cap, elect, 200 uf -10/+75%, 12V	1502-150284	56289	30D207G012DF4	2	1	
CR1, CR2	Diode, Ge, 125 PIV, 75 ma	4802-150342	93332	1N277	2	1	
CR3	Diode, zener, Si, 14V, 9 ma	4803-150334	07910	CD36612	1	1	
R1, R2	Res, comp, 10K ±10%, 1W	4704-109389	01121	GB1031	2		
R3, R4	Res, comp, 100Ω ±10%, 1/2W	4704-108100	01121	EB1011	2		
T1	Transformer	5602-160192	89536	A84-651	1		
	Line cord, 6 feet	6004-159079	70903	18122	1		

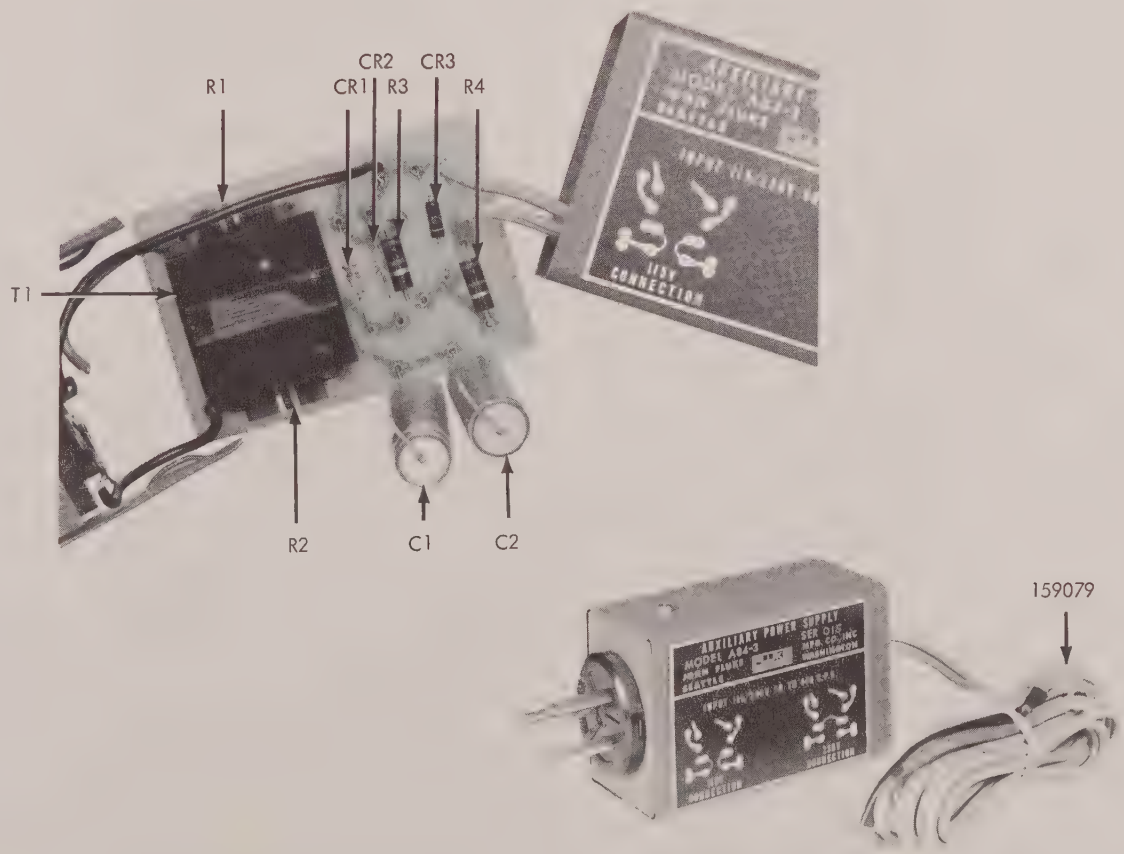


Figure 5-5. AC POWER RACK

5-11. USE CODE EFFECTIVITY

The following list of use codes is intended to allow the customer to determine the effectivity of all replaceable parts. All parts with no code are used on all instruments with serial numbers above 123. New codes will be added as necessary on forthcoming instruments.

USE CODE	EFFECTIVITY
No Code	Model A88 serial number 123 and on

APPENDIX A

FEDERAL SUPPLY CODE FOR MANUFACTURERS

A-1. CODE TO NAME

A-2. The following five-digit code numbers are listed in numerical sequence along with the manufacturer's name and address to which the code has been assigned. The Federal Supply Code has been taken from Cataloging Handbook H 4-2, Code to Name. Suppliers not listed in the Federal Supply Code for Manufacturers have been assigned an alphabetical code by FLUKE.

00213	Sage Electronics Corp. Rochester, New York
00327	Welwyn International, Inc. Cleveland, Ohio
00656	Aerovox Corp. New Bedford, Massachusetts
01121	Allen-Bradley Company Milwaukee, Wisconsin
01281	Pacific Semiconductors Inc. Lawndale, California
01295	Texas Instruments, Inc. Semiconductor Components Div. Houston, Texas
01730	Circle Mfg. Co. Inc. Little Falls, New Jersey
01884	Dearborn Electronic Labs Inc. Orlando, Florida
01963	Cherry Electrical Products Corp. Highland Park, Illinois
02660	Amphenol-Borg Elect. Corp. Chicago, Illinois
02606	Fenwal Laboratories Inc. Framington, Massachusetts
02799	Arco Capacitors, Inc. Los Angeles, California
03614	Bussmann Mfg. Div. of McGraw-Edison Co. Los Angeles, California
03615	Ohmite Mfg. Co. Los Angeles, California
03877	Transitron Electronic Corp. Wakefield, Massachusetts
03911	Clairex Corp. New York, New York
03980	Muirhead Instruments, Inc. Mountainside, New Jersey
04009	Arrow Hart and Hegemen Electronic Company Hartford, Connecticut
04062	Elmenco Products Company New York, New York
04202	Winchester Electronics Co. New Milford, Connecticut
04221	Telex-Aemco Division of Telex Corp. Mankato, Minnesota
04645	Kurz-Kasch, Inc. Chicago, Illinois
04713	Motorola Inc. Semiconductor Products Division Phoenix, Arizona
05082	Tung-Sol Electric Inc. Melrose Park, Illinois
05278	Penn-East Engrg. Corp. Kutztown, Pennsylvania
05397	Union Carbide Corp. Linde Division Kemet Dept. Cleveland, Ohio
05571	Sprague Electric Company Culver City, California
05704	Alac, Inc. Glendale, California
06001	General Electric Company Capacitor Department Irmo, South Carolina
06136	Ward Leonard Electric Co. Los Angeles, California
06473	Amphenol Space and Missile Sys Chatsworth, California
06555	Beede Electrical Inst. Co. Penacook, New Hampshire
06751	Nuclear Corporation of America, Inc. U. S. Semcor Div. Phoenix, Arizona
06860	Gould National Batteries Inc. La Puente, California
07115	Corning Glass Works Electronic Components Dept. Bradford, Pennsylvania
07263	Fairchild Semiconductor Div. of Fairchild Camera and Instrument Corp. Mountain View, California
07344	Bircher Co., Inc. Rochester, New York
07792	Lerma Engineering Corp. Northampton, Massachusetts
07910	Continental Device Corp. Hawthorne, California
08530	Reliance Mica Corp. Brooklyn, New York
08863	Nylomatic Corp. Morrisville, Pennsylvania
08988	Skottie Electronics Inc. Peckville, Pennsylvania
11237	Chicago Telephone of Calif Inc. South Pasadena, California
11503	Keystone Mfg. Co. Warren, Michigan
12060	Diodes, Inc. Chatsworth, California
12136	Philadelphia Handle Co. Camden, New Jersey
12400	International Resistance Co. Control Components Division Philadelphia, Pennsylvania
12617	Hamlin Inc. Lake Mills, Wisconsin
12697	Clarostat Mfg. Co. Dover, New Hampshire
14099	Semtech Corp. Newbury Park, California
14193	California Resistor Corp. Santa Monica, California
14298	American Components Inc. Conshohocken, Pennsylvania
14752	Electro Cude Inc. South Pasadena, California
15818	Amelco Inc. Mountain View, California
15909	Daven Division Thomas A. Edison Ind. McGraw Edison Co. Livingston, New Jersey
16332	Milwaukee Relays Inc. Cedarburg, Wisconsin
16473	Cambridge Scientific Industries Inc. Cambridge, Maryland
17069	Circuit Structures Lab Santa Ana, California
17856	Siliconix Inc. Sunnyvale, California
17910	Continental Device Corp. Hawthorne, California
18083	Clevite Corp. Transistor Division Palo Alto, California
19429	Montronics, Inc. Seattle, Washington
19701	Electra Mfg. Co. Independence, Kansas
24655	General Radio Co. West Concord, Mass.
28520	Heyman Mfg. Co. Kenilworth, New Jersey
33173	General Electric Co. Tube Dept. Owensboro, Kentucky
37942	P. R. Mallory and Co., Inc. Indianapolis, Indiana
38315	Honeywell Inc. Precision Meter Division Manchester, New Hampshire
42498	National Company, Inc. Malden, Massachusetts
44655	Ohmite Mfg. Co. Skokie, Illinois
49671	Radio Corp. of America New York, New York
53021	Sangamo Electric Co. Springfield, Illinois
55026	Simpson Electric Company Chicago, Illinois
56289	Sprague Electric Co. North Adams, Mass.
58474	Superior Electric Co. Bristol, Connecticut
60399	Torrington Mfg. Co. Torrington, Connecticut
62460	USHCO Mfg. Co., Inc. Buffalo, New York
64834	West Mfg. Co. San Francisco, California
65092	Weston Instruments Div. of Daystrom, Inc. Newark, New Jersey
66150	Winslow Tele-Tronics Inc. Asbury Park, New Jersey
70563	Amperite Co. Union City, New Jersey
70903	Belden Mfg. Co. Chicago, Illinois

71400 Bussman Manufacturing Division of McGraw Edison Co. St. Louis, Missouri

71450 CTS Corp. Elkhart, Indiana

71468 Cannon Electric Company Los Angeles, California

71482 Clare, C. P. and Company Chicago, Illinois

71590 Centralab Div. of Globe Union, Inc. Milwaukee, Wisconsin

71707 Coto Coil Co., Inc. Providence, Rhode Island

71744 Chicago Miniature Lamp Works Chicago, Illinois

71785 Cinch Mfg. Co. and Howard B. Jones Div. Chicago, Illinois

72005 Driver, Wilber B., Co. Newark, New Jersey

72092 Eitel-McCullough, Inc. San Bruno, California

72136 Electro Motive Mfg. Co. Willimantic, Connecticut

72354 Fast, John E. Co. Div. of Victoreen Instr. Co. Chicago, Illinois

72559 Essex Electronics Inc. Berkeley Heights, New Jersey

72619 Dialight Corp. Brooklyn, New York

72665 Mallory Battery Company Cleveland, Ohio

72982 Erie Tech. Products Inc. Erie, Pennsylvania

73138 Helipot Division of Beckman Instruments Inc. Fullerton, California

73293 Hughes Products Div. of Hughes Aircraft Co. Newport Beach, California

73445 Amperex Electronic Co. Div. of North American Philips Co., Inc. Hicksville, New York

73559 Carling Electric Inc. Hartford, Connecticut

73586 Circle F Mfg. Co. Trenton, New Jersey

73899 JFD Electronics Corp. Brooklyn, New York

73949 Guardian Electric Mfg. Co. Chicago, Illinois

74217 Radio Switch Corp. Marlboro, New Jersey

74306 Piezo Crystal Company Carlisle, Pennsylvania

74542 Hoyt Elect. Instr. Works Penacook, New Hampshire

74970 Johnson, E. F., Co. Waseca, Minnesota

75042 International Resistance Co. Philadelphia, Pennsylvania

75915 Littelfuse Inc. Des Plaines, Illinois

76854 Oak Mfg. Co. Crystal Lake, Illinois

77342 American Machine and Foundry Company Potter & Brumfield Div. Princeton, Indiana

77969 Rubbercraft Corp. of California Ltd. Torrance, California

78277 Sigma Instruments, Inc. South Braintree, Mass.

79136 Waldes Kohinoor Inc. Long Island City, New York

79497 Western Rubber Company Goshen, Indiana

80031 Mepco Division of Sessions Clock Co. Morristown, New Jersey

80294 Bourns Laboratories, Inc. Riverside, California

80583 Hammarlund Company, Inc. New York, New York

80640 Stevens, Arnold Co., Inc. Boston, Massachusetts

81073 Grayhill Company La Grange, Illinois

81439 Therm-O-Disc Inc. Mansfield, Ohio

81483 International Rectifier Corp El Segundo, California

81590 Korry Mfg. Co. Seattle, Washington

82376 Astron Division Renwell Industries Inc. East Newark, New Jersey

82389 Switchcraft Inc. Chicago, Illinois

82872 Roanwell Corp. Brooklyn, New York

82877 Rotron Mfg. Co., Inc. Woodstock, New York

82879 Royal Electric Corp. Pawtucket, Rhode Island

83003 Varo Mfg. Co., Inc. Garland, Texas

83298 Bendix Corp. Red Bank Division Red Bank, Eatontown, New Jersey

83330 Smith, Herman H., Inc. Brooklyn, New York

83478 Rubbercraft Corp. of Am. New Haven, Connecticut

84411 Good All Electric Mfg. Co. Ogallala, Nebraska

86689 R. M. B. Corp. Los Angeles, California

88419 Cornell-Dubilier Elec. Corp. Electro-Mechanical Div. Fuquay Springs, North Carolina

88690 Essex Wire Corp. R. B. M. Division Detroit, Michigan

89536 Fluke, John, Mfg. Co., Inc. Seattle, Washington

89730 General Electric Company Newark Lamp Works of Lamp Division of Consumer Products Group GECO Newark, New Jersey

90205 Best Stamp and Mfg. Co. Kansas City, Missouri

90211 Square D Company Chicago, Illinois

90303 Mallory Battery Company North Tarrytown, New York

91293 Johanson Mfg. Co. Boonton, New Jersey

91407 Superior Electric Company Oak Park, Illinois

91662 Elco Corp. Willow Grove, Penn.

91737 Gremar Mfg. Co., Inc. Wakefield, Massachusetts

91802 Industrial Devices, Inc. Edgewater, New Jersey

91929 Minneapolis Honeywell Regulator Company Micro Switch Division Freeport, Illinois

91934 Miller Electric Co., Inc. Pawtucket, Rhode Island

93332 Sylvania Electric Products Inc. Semiconductor Products Division Woburn, Massachusetts

94145 Raytheon Company Semiconductor Division California Street Plant Newton, Massachusetts

95146 Alco Electronics Mfg. Co. Lawrence, Massachusetts

95264 Lerco Electronics Inc. Burbank, California

95303 Radio Corp. of America Comm. Receiving Tube & Semiconductor Division Cincinnati, Ohio

95354 Methode Mfg. Co. Chicago, Illinois

95712 Dage Electric Co., Inc. Franklin, Indiana

96733 San Fernando Electric Mfg. Co. San Fernando, California

96881 Thomson Industries, Inc. New Hyde Park Long Island, New York

97945 S. S. White Dental Mfg. Co. Plastics Division New York, New York

97966 CBS Electronics Div. of Columbia Broadcasting System, Inc. Danvers, Massachusetts

98094 Penta Laboratories, Inc. Santa Barbara, California

98388 Accurate Sales Company Culver City, California

98743 James Vibrapower Corp. Chicago, Illinois

98925 Semiconductor Division of Clevite Corp. Waltham, Massachusetts

99120 Plastic Capacitors, Inc. Chicago, Illinois

99217 Southern Electronics Corp. Burbank, California

99515 Marshall Industries Electron Prod. Div. Pasadena, California

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WARRANTY

The JOHN FLUKE MFG. CO., INC. warrants each instrument manufactured by them to be free from defects in material and workmanship. Their obligation under this Warranty is limited to servicing or adjusting an instrument returned to the factory for that purpose, and to making good at the factory any part or parts thereof; except tubes, fuses, choppers and batteries, which shall, within one year after making delivery to the original purchaser, be returned by the original purchaser with transportation charges prepaid, and which upon their examination shall disclose to their satisfaction to have been thus defective. If the fault has been caused by misuse or abnormal conditions of operation, repairs will be billed at a nominal cost. In this case, an estimate will be submitted before work is started, if requested.

If any fault develops, the following steps should be taken.

1. Notify the John Fluke Mfg. Co., Inc., giving full details of the difficulty, and include the Model number, type number, and serial number. On receipt of this information, service data or shipping instructions will be forwarded to you.

2. On receipt of the shipping instructions, forward the instrument prepaid, and repairs will be made at the factory. If requested, an estimate of the charges will be made before the work begins, provided the instrument is not covered by the Warranty.

SHIPPING

All shipments of John Fluke Mfg. Co., Inc. instruments should be made via Railway Express prepaid. The instrument should be shipped in the original packing carton; or if it is not available, use any suitable container that is rigid. If a substitute container is used, the instrument should be wrapped in paper and surrounded with at least four inches of excelsior or similar shock-absorbing material.

CLAIM FOR DAMAGE IN SHIPMENT

The instrument should be thoroughly inspected immediately upon receipt. All material in the container should be checked against the enclosed packing list. The manufacturer will not be responsible for shortages against the packing sheet unless notified immediately. If the instrument fails to operate properly, or is damaged in any way, a claim should be filed with the carrier. A full report of the damage should be obtained by the claim agent, and this report should be forwarded to John Fluke Mfg. Co., Inc. Upon receipt of this report you will be advised of the disposition of the equipment for repair or replacement. Include the model number, type number, and serial number when referring to this instrument for any reason.

The John Fluke Mfg. Co., Inc. will be happy to answer all application questions which will enhance your use of this instrument. Please address your requests to:

JOHN FLUKE MFG. CO., INC., P. O. BOX 7428, SEATTLE 33, WASHINGTON

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